East Pakistan

POSSIBILITIES FOR CEREAL FORTIFICATION

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Foreign Economic Development Service
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Introduction

Technological advances in modern low-cost medicine have made it possible for the developing countries to increase life expectancies to levels much beyond the longevity of Europeans and Americans when they were at comparable income levels.

Technological advances of comparable magnitude now exist in food science which can enable developing countries to accelerate improvements in nutrition. One of the most promising techniques of improving nutrition is fortification -- the addition of vitamins, minerals and/or amino acids to such foods as cereals.

The conventional approach for combating malnutrition is to increase the total intake and variety of foods, including animal products as a source of protein. But low incomes seriously limit the ability of families to obtain, prepare and consume these types of foods. Following a "higher income" approach, it will be years before lower income people could eat nutritionally adequate diets from traditional type foods. Therefore, certain short-cuts to improved nutrition, one of which is fortification, are often appropriate. Fortification is one alternative which has the potential to correct malnutrition in a time span never thought possible before -- and, at a minimum of cost.

Low-cost vitamins and minerals have been available for many years. And more recently, breakthroughs have made synthetic amino acids available at a fraction of the cost of comparable traditional sources of these nutrients.

A number of fortification efforts ranging from feeding studies to commercial ventures are underway in countries such as Tunisia, Thailand, Guatemala, India and the United States. These involve the fortification of the major cereals, wheat, rice and corn with amino acids, vitamins and minerals.

Summary

The team believes that widespread malnutrition in East Pakistan is hindering efforts to improve peoples' health, raise living standards and accelerate the economy. Traditional methods of improving nutrition--by increasing consumption of such foods as meat, milk and eggs--are long-term propositions dependent on much higher incomes. Fortification of cereals with vitamins, minerals and amino acids appears to be a sound short-cut to improved nutrition.

Rice, East Pakistan's principal food, is a poor source of riboflavin. Further, it does not contain a large quantity of protein; that which is present is inefficiently utilized because of its amino acid composition. It is a principal candidate for fortification.

The marketing system for domestically-produced cereals, including rice, is quite dispersed and is composed of many small entities. This shortage of central marketing points makes widespread fortification extremely difficult.

However, imported cereal moves through a small number of central marketing points. Currently, the Food Department of the East Pakistan Government imports and distributes both wheat and rice through its system of godowns and licensed ration shops, and selected industrial concerns. These cereal imports amount to one million tons of the nearly 12 million consumed yearly in East Pakistan.

The team feels that the strategic role of the government rationing system offers an excellent opportunity for future cereal fortification schemes. Since wheat has a dominant role in cereal imports, it should also be considered a fortification candidate.

Before deciding on the future role of cereal fortification in East Pakistan, that Government should consider these three pilot projects:

1. Fortification of cereal distributed through company ration shops of selected cotton, jute or tea companies.

2. Fortification of cereal distributed through the D_1 ration zone of Dacca town.

3. Marketing and promotion of fortified premix for rice.

The overall objectives of these projects would be to:

1. Identify the administrative and management requirements of fortification programs.

2. Evaluate the medical benefits of fortification.

3. Define technological procedures necessary to successfully fortify cereal under East Pakistan marketing and processing systems and cooking methods.

4. Evaluate the economic and marketing dimensions of fortification programs.

Nutritional Problems of East Pakistan

The most comprehensive study documenting the nutritional status of East Pakistan's population is the joint Pakistan-United States Nutrition Survey of East Pakistan conducted from March 1962 to January 1964. 1/ The results of this survey and the observations of nutritionally trained health personnel clearly indicate that there are major nutritional problems in East Pakistan. These problems are so serious that they compromise all efforts to improve the economy, raise the standard of living and improve the health of the people. Foremost among these nutritional problems are deficiencies of calories, protein and vitamin A, each of which exacts a heavy toll on productivity, health and happiness. Of significance also are deficiencies of riboflavin, iron (often caused by parasitic disease) and, in a few places where parboiled rice is not consumed, thiamine.

Most available statistics are in terms of averages. However, averages do not provide sensitive measures of the nutritional status of individuals within a society. There are wide deviations from the averages of family food consumption data among rural families and among urban families of different incomes and habits. Thus, a significant part of the East Pakistan population has diets substantially below average levels.

Also, within families, food is often not proportionally distributed among its members. The East Pakistan family is usually dependent on the male head of the house for its support and his work is often high-energy consuming. Consequently, it is necessary for adult males to consume a disproportionate share of the food available to the family. This phenomenon, in turn, limits the food available to the very young, pregnant women, lactating mothers and others with special nutritional needs. Thus, malnutrition is a common affliction among these vulnerable groups.

The inadequate nutritional levels of East Pakistanis, documented by the "Nutrition Survey of East Pakistan, March 1962-January 1964" have not improved significantly and may have deteriorated in recent years. For example, cereal production increased in the 1960's. But the increases did not keep pace with population growth. Per capita cereal production averaged less than 310 pounds in the late 1960's in comparison to 335 pounds in the first years of the decade. (Figure 1) Furthermore, the distribution of imported cereals by the Food Department did not offset the shortfall in production (small amounts distributed were procured domestically). These developments together with stagnation of pulse production (high protein edible legumes) resulted in lower per capita cereal and pulse consumption in the late 1960's.

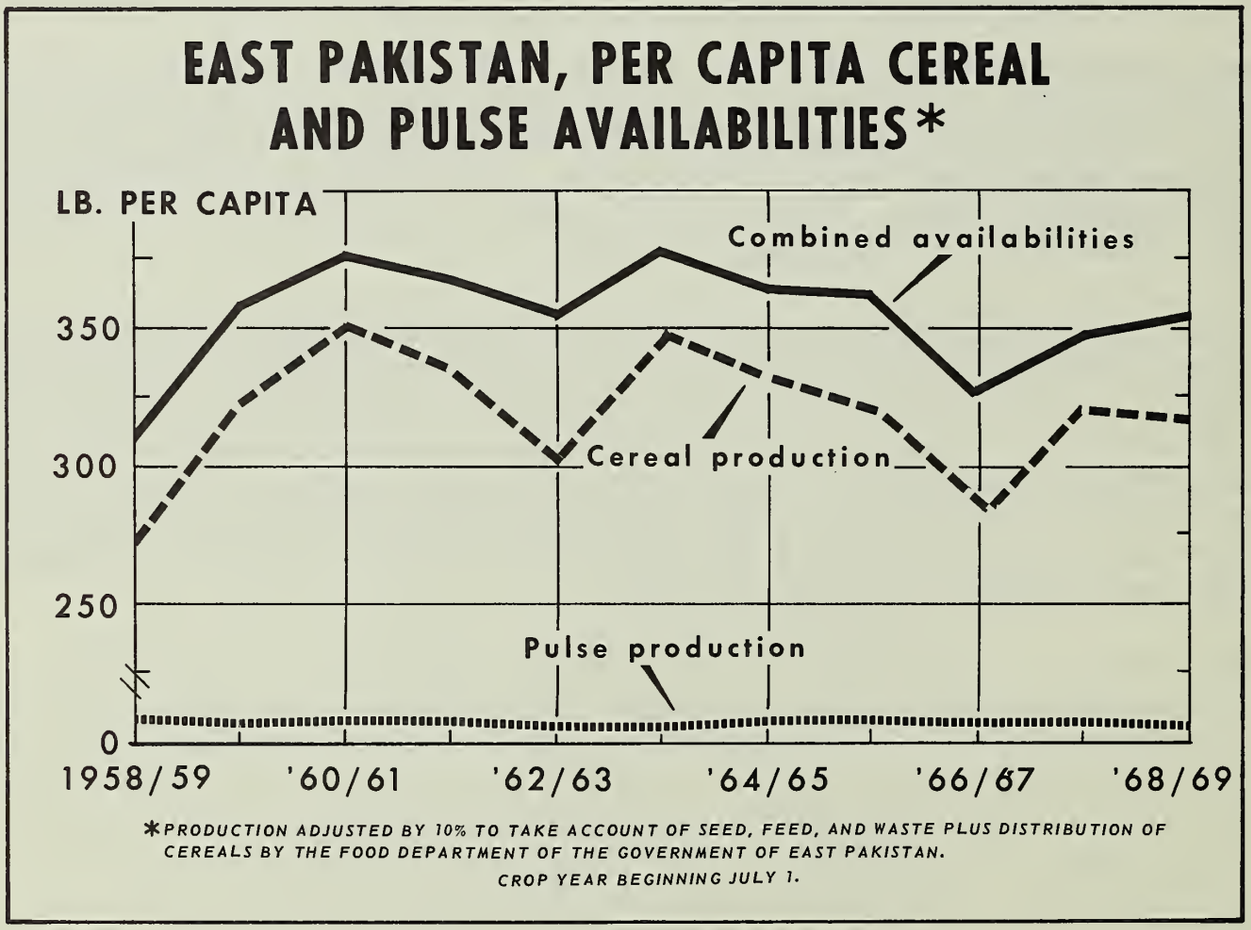
1/ Nutrition Survey of East Pakistan, March 1962-January 1964, U. S. Dept. of Health, Education and Welfare, 1966.

Recent studies 2/ have shown that malnutrition, especially protein deficiencies, may adversely affect mental development of children. This relationship obviously has great implications for future productivity of the people and the country.

Further, it has long been recognized that, aside from the effects of protein deficiencies on mental development, malnutrition adversely affects the physical development of children and lowers their resistance to infection.

Therefore, humanitarian considerations aside, money spent on nutrition and other health programs can affect the destiny of a country.

FIGURE 1



2/ Eichenwald, Heinz F., and Fry, Peggy C., "Nutrition and Learning," Science Vol. 163, February 1969, pp. 644-648.

Monckeberg, Fernando, "Malnutrition and Mental Behaviour," Nutrition Reviews, Vol. 27, July 1969, pp. 191-193.

Nutritive Properties of Rice

Rice is the main staple of the diets for about half the world's population. The nutritive value of the rice consumed by these people varies enormously and depends on many factors including variety, growing conditions, milling procedures and methods of preparation. 3/

Rice is a poor source of minerals and fat, does not contain vitamin A and is quite low in riboflavin. Its outer coat contains generous quantities of thiamine often lost because of overmilling and poor cooking practices. Fortunately, much of the rice consumed in East Pakistan is parboiled or undermilled. This preserves the thiamine. Thus, beri beri, a thiamine deficiency disease, is a minor problem compared to many other parts of Asia. However, the widespread practices in East Pakistan of extensively washing rice before it is cooked and then cooking with large amounts of water which are later poured off cause significant losses of vitamins and minerals. Although the protein content of rice is generally regarded as being about 7 percent, analyses have disclosed a range from 4-14 percent among the hundreds of varieties of rice.

Equal in importance to the quantity of protein is the relative proportions of the constituent amino acids in the protein. These proportions determine the utilization of the protein. In rice protein, the amino acids lysine and threonine are deficient with respect to the other amino acids. Consequently an increase in lysine and threonine content would increase the amount of protein (amino acids) utilized by the body. Wheat protein is deficient in lysine. It has been demonstrated that addition of 0.2 grams of lysine to 100 grams of wheat flour increase the "biologically utilizable protein" by approximately two grams. This increase is equivalent to an increase of 33 percent in the utilizable protein of wheat.

Animal experiments indicate the addition of lysine and threonine to rice increases the utilization of its protein approximately 25 percent. Projects in institutions such as hospitals and orphanages also show a positive relationship between the addition of amino acids to rice and amount of protein utilized. Therefore, fortification of rice with lysine and threonine has been proposed as one method for effectively increasing the protein supply of rice-eating populations.

3/ Houston, D. F., and Kohler, G. O., Nutritional Properties of Rice, National Academy of Sciences, 1970.

Rationale of Fortification

The conventional approach to alleviate nutrient malnutrition of any type is to increase the quantity and variety of foods in the diet. To combat protein malnutrition, an increase in the dietary intake of protein from animal sources is usually given great emphasis. However, both variety and amount of animal protein intakes are related to income. In most cases, as family incomes go up, a larger number of foods are eaten and the quantity of animal products consumed increases with a subsequent reduction in malnutrition. It is not realistic to expect these approaches to be meaningful at this time for large numbers of impoverished people. Therefore, it is imperative that developing countries uncover and utilize all alternative methods which are economically feasible at their current stage of development. One such alternative approach for countries where a few foods such as cereals make up the bulk of the people's diet day after day is fortification.

Fortification of foods is generally defined as the nutritional improvement of widely-consumed foods by the addition of nutrients such as vitamins, minerals and amino acids (or other protein supplements) without any detectable change in appearance, flavor and technological properties. These nutrients may or may not have been present in the food at harvest. For example, certain B vitamins are added to wheat flour in the United States to replace the quantities lost during milling. Iodine is added to salt and vitamin D to milk though both nutrients are not present in the unprocessed food.

For poor countries or poor segments within a country, fortification of cereals such as rice, wheat and corn appears to be a feasible approach for immediately overcoming nutrient malnutrition caused by poverty. If all cereals in East Pakistan were fortified with vitamin A, blindness due to vitamin A deficiency would cease to be a major health and economic problem. Cereal fortification with amino acids is particularly important as a low cost method for combating protein malnutrition in cereal-consuming cultures.

In summary, recent developments in fortification technology and nutrition knowledge have created an opportunity similar to that which occurred in the field of medicine. Technological advances through modern low-cost medicine have made it possible for the developing countries to increase life expectancies to levels much beyond the longevity of Europeans and Americans when they were at comparable income levels. For example, the life expectancy and per capita income in India is now 50 years and $70, respectively 4/. The United States achieved a 50-year life expectancy in 1910 at a per capita income level of $1400. It is believed that fortification could enable the developing countries to accelerate improvement in the nutrition of their people at a faster rate than income improvement.

A number of projects located throughout the world are described below. The purpose of these projects is to define and evaluate the effectiveness of

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4/ Data obtained from Alan Berg, formerly Chief of Food and Nutrition Division, AID/India.

fortifying cereals with amino acids, minerals and vitamins. This listing includes only those efforts with which the U. S. Department of Agriculture (USDA) and the Agency for International Development (AID) have been actively involved in the past few years.

Another section includes results of human feeding studies designed to measure the effects of fortification on human growth, development and health.

United States Experience

The Pillsbury Company is currently market-testing five pound bags of wheat flour fortified with 0.3 percent lysine and double the amount of iron and double the amount of the vitamins B_1, B_2 and niacin normally added to U. S. fortified flour. The locale of this market test is in a low-income area of Chicago. The flour is advertised as nutritionally improved. The additional store cost associated with the fortification is 2 cents per five pound bag. Initial acceptance as indicated by sales has been good indicating an interest in their nutrition by the low-income people in this area.

The USDA has recently purchased 4.9 million pounds of bulgur (parboiled whole wheat) fortified with 0.1 percent lysine for shipment to Nigeria. This lysine-fortified bulgur is part of the protein food pledge for Nigeria by President Nixon.

Tunisia Project

A large-scale program to evaluate the effects of wheat fortification under real-life conditions is currently being carried out in Tunisia.

The Tunisian Government through its National Institute of Nutrition is actively involved with the Department of Nutrition of the Harvard School of Public Health in carrying out the program which is supported, in part, by AID. USDA and Pillsbury Company are supplying technical assistance. In addition to giving full-time assignments to some of its personnel to work on the program, the Institute has obtained the cooperation of wheat millers, macaroni manufacturers and both private and public groups involved in the Tunisian food distribution system. Without this interest and cooperation, the program would not be possible.

Wheat flour and macaroni products are being fortified at two plants in Tunis and sent to a region in Southern Tunisia where a negligible amount of wheat is grown. The 70,000 people in this region receive up to 80 percent of their total calories and protein from wheat. This region has been divided into three areas as follows: a control; an area receiving wheat products fortified with vitamins and minerals; and an area receiving wheat products fortified with vitamins, minerals and lysine. In addition to medical examinations and biochemical measurements of blood and urine of approximately 2,000 children, mortality and morbidity data in the three areas will be statistically analyzed. The potential for adding an evaluation to determine economic effects is being explored at this time. The program which was begun in late 1969 is scheduled to run a minimum of four years. Preliminary evaluation data should be available in two years.

Thailand Project

The Division of Nutrition of the Thai Department of Health in association with the Department of Nutrition of the Harvard School of Public Health has recently initiated a rice fortification study in villages in northern Thailand. The project is supported by technical personnel of the Thai Government and AID funds. This project is of interest to East Pakistan because there are similarities in the nutritional habits and problems of the people of Thai villages and East Pakistan. In rural Thailand more than 80 percent of the calorie intake is obtained from rice. There is little fat or animal protein in the diets. Deficiencies of protein, vitamin A and riboflavin are prevalent. Anemias, many caused by parasitic infections and which are responsive to iron therapy, are a major problem. In contrast to East Pakistanis, Thais experience widespread thaimine deficiency since they do not parboil their rice.

The Thai studies are being conducted in relatively isolated small villages where the entire rice supply is milled in one or two mills. The fortification premix is being added to the rice by a feeder attached to each mill. Daily surveillance of the fortification is being conducted by representatives of the Thai Division of Nutrition.

The fortification premixes being used consist of RFG (rice fortification granules) produced in Japan. The composition of these granules can be altered as desired. They have been designed to look and cook like rice and, as used, do not affect the taste of rice. Loss of nutrients from RFG in cooking is minimal.

Three types of RFG are being used. One contains lysine, threonine, vitamin A, thiamine and iron; another vitamin A, thiamine and iron; and the third is a placebo (an RFG with no nutrients).

The following data have been collected. In each village, before the start of fortification, a complete census has been made. The dates of birth of all individuals have been recorded. Histories of illness, stillbirths, deaths among children and immunization have been taken. Dietary surveys of food consumption of 10 percent of the families randomly selected have been conducted. All pre-school children 1-7 years of age have received a physical examination which has been designed to determine the presence of physical signs of nutritional deficiency. Height, weight, head, arm and chest circumferences and subscapular and triceps skin fold thicknesses have been measured. In addition, hand-wrist X-rays and an examination for intestinal parasites are being obtained. Hemoglobin and hematocrit determinations will be routinely done on the blood of pre-school children and their mothers.

At regular intervals in the fortification study, these examinations will be repeated. In addition records of birth weight of new born infants will be maintained. Besides the villages receiving the three types of RFG, similar data will be collected from other villages having no RFG program. It is expected that approximately 12,000 people will participate in this study.

The program was designed to obtain an objective detailed evaluation of the health benefits which can be expected from the use of the fortification premixes as used in this study.

The first 12 months of the project are being used to pretest the fortification procedure, develop administrative techniques and compile baseline medical information. Plans are for the study to continue for three to four years including the pretesting time. Preliminary information may be available as early as 1971.

Guatemala Project

In Guatemala, the Institute of Nutrition for Central America and Panama (INCAP) and the Department of Food Science at Rutgers University are investigating the technological feasibility of fortifying corn masa. There are a relatively large number of small mills in Central American countries where people take their corn to be ground into masa which can be made into tortillas in the home. Any significant corn fortification program in Central America will have to involve these small mills. The willingness of the millers to add nutrients and the willingness of consumers to purchase fortified masa, as well as the technological feasibility of the alternative methods are being studied. If the technological feasibility is demonstrated and the attitude of the consumers and millers is positive, it is anticipated the project will be greatly expanded. A medical-nutritional evaluation will be included in an expanded project.

Activities in India

A variety of fortification activities are underway in India. Some of the more important efforts are as follows:

Modern Bread. By the end of 1970 Modern Bakeries expect to be selling 100 million loaves of Modern Bread annually. This bread, produced in government-controlled bakeries, is fortified with lysine, vitamins and minerals. It is justly advertised as the most nutritious bread in the world and represents the largest amino acid program anywhere.

Salt and Tea. These commonly-consumed items are being studied as carriers of nutrients. Initial results indicate that salt may be a promising way to add calcium to the Indian diet. Results thus far with tea fortified with vitamin A or lysine are encouraging.

Atta. Particular attention is being given to the possibilities of fortifying atta (coarsely-ground whole wheat) with protein concentrates prepared from peanuts. Peanut protein, as is wheat protein, is deficient in lysine. Therefore, to achieve maximum nutritional benefit, consideration is being given to adding lysine to atta fortified with peanut protein. In February 1970 the Government of India announced that atta sold in the Government fair price shops throughout India would be fortified with edible peanut flour (45-50% protein), vitamins and minerals.

This event reflects a national nutrition policy adopted by the Government of India. In line with this national policy, a group of leading food industrialists and scientists have organized a

Protein Foods Association to advance the commercial development and marketing of protein foods.

Feeding Studies. As noted in the following section, Dr. Sheila Pereira is carrying out human feeding studies with lysine fortified wheat and rice. Other human and animal feeding studies are underway in numerous private and government-sponsored laboratories and institutions.

Human Feeding Studies

A number of human feeding studies have been carried out in many countries under closely controlled conditions in institutions such as hospitals and orphanages. These studies have demonstrated the nutritional benefits of cereal fortification.

The following studies are the two most recent examples:

Dr. George Graham and co-workers conducted a project at the British American Hospital in Lima, Peru. The project was designed to measure the effect on infants of fortifying wheat flour with lysine. They found that "The equivalent of 0.12 percent lysine enrichment of white wheat flour resulted in significant enhancement of its protein value for the rapidly growing human infant." 5/ They concluded that "enrichment of white wheat flour with lysine to the 0.12 percent and possibly the 0.2 percent level is recommended for those areas in which this cereal serves as the main source of protein in the diet, particularly that of infants and children."

Dr. Pereira and co-workers at the Christian Medical College in Vellore, South India, carried out a feeding trial designed to study in an orphanage the effect of lysine supplemented wheat on the growth of preschool children. They found a statistically significant increase in height in the children fed lysine supplemented wheat compared with the children who served as controls on unsupplemented wheat. 6/ The wheat used in the diets provided 54 percent of daily calories and 85 percent of the daily protein. Dr. Pereira is now carrying out a similar feeding trial with rice.

The previously noted Thailand study on rice and Dr. Pereira's rice trial will measure under field and closely-controlled conditions respectively the nutritional benefit of fortifying rice for human use with amino acids, as well as vitamins and minerals.

A great number of animal studies with fortified rice have shown beneficial effects. The results of these studies have been confirmed by Professor Mark Hegsted of Harvard in recent work done in connection with the Thailand study.

5/ Graham, George G., et al., "Lysine Enrichment of Wheat Flour: Evaluation in Infants," The American Journal of Clinical Nutrition, Vol. 22, No. 11, November 1969, pp. 1459-1468.

6/ Pereira, Sheila M., et al., "Lysine-Supplemented Wheat and Growth of Preschool Children," The American Journal of Clinical Nutrition, Vol. 22, No. 5, May 1969, pp. 606-611.

Fortification Techniques and Costs

Rice

Japanese companies have developed techniques for fortification of rice whereby a premix of RFG (see page 8) is prepared. Prior to cooking, these granules are mixed with regular rice in the ratio of 1 part to 100 parts of regular rice. We shall refer to the resulting mix as "fortified rice" to distinguish it from the premix of RFG.

According to their manufacturers, these premixes are made so that they are essentially non-leaching. Thus, nutrients lost in the excess cooking water should be minimal.

The premix for the fortification of rice may be prepared by one of the following two methods:

(1) Natural rice kernels are impregnated with the nutrients by infusion or covered with an adherent mixture of finely powdered nutrients and subsequently protected against washing, rinsing and cooking losses by spraying with an edible coating material. This technique is used by the Kyowa Hakko Kogyo Company.

(2) The nutrients are mixed with carriers such as rice starch and gluten to form a stiff dough which is extruded through a macaroni press into the form of rice kernels. These are being made by the Ajinomoto Company for use in the Thailand project.

The rice fortification premix we recommend for East Pakistan should contain vitamins A, B_1 and B_2 and iron. There should be enough of these in 200 grams of fortified rice to provide the daily needs of a healthy child and enough in 300 grams of fortified rice to provide the daily needs of an adult when part of the usual East Pakistan diet.

Our recommended levels of lysine and threonine to be included in the premix are based on animal feeding studies designed to determine the amounts of these amino acids to be added to rice to obtain maximum growth rates.

We estimate that a premix having the levels of vitamins and minerals given in Table 1 would cost $0.47 to $0.84 per maund of rice (including preparation costs shown in Table 2). The uncertainty of the price of threonine accounts for the spread. Threonine currently sells at $7.50 per pound. It is generally anticipated that with increasing demand for this amino acid and with technological advances in its production, the price of threonine will be reduced to $3.00 per pound. In fact, there are indications that a recent threonine production breakthrough might lead to the lower price within a short period. Lysine currently costs $1.00 per pound.

The following table indicates the suggested levels of vitamins, minerals and amino acids to include in a premix for the fortification of 500 grams of rice and related estimates of the cost of the nutrients.

TABLE 1

RICE FORTIFICATION: RECOMMENDED LEVELS OF NUTRIENTS AND RELATED COST ESTIMATES

Nutrient	Amounts added to fortify 500 grams of rice 1/	Cost		
		Per kg. of nutrient	Per 500 grams fortified rice	Per metric ton fortified rice
Vitamins		-U.S. dollars-	--U.S. cents--	-U.S. dollars-
A	5000 I.U. 2/	.05 per 1 million I.U.	.025	0.50
B_1	1.2 mg.	14.75	.00177	0.04
B_2	1.8 mg.	32.00	.00576	0.12
Minerals				
Iron	10.0 mg.	1.10	.0011	0.02
Amino Acid				
L - Lysine	1.0 gm.	2.20	.22	4.40
L - Threonine	0.5 gm.	6.60 3/ (16.50 4/)	.33 3/ (.825 4/)	6.60 3/ (16.50 4/)

Total nutrient cost per metric ton based on projected threonine price = $11.68
Total nutrient cost per metric ton based on current threonine price = $21.58

1/ It is anticipated that these amounts would be incorporated in a premix of RFG's weighing approximately 5 grams.

2/ International Unit.

3/ Projected price.

4/ Current price.

In addition to nutrient cost, we estimate that the expense of preparing enough premix from these nutrients to fortify one metric ton of rice would be $1.00. In Table 2 the preparation cost is combined with nutrient costs to indicate the total cost of the premix.

TABLE 2

ESTIMATED TOTAL COST OF PREMIX FOR FORTIFYING RICE 1/

Threonine prices	Nutrient costs 2/	Preparation costs 2/	Total costs	
			Per metric ton	Per maund 3/
	U.S. dollars			
Projected level	11.68	1.00	12.68	0.47
Current level	21.58	1.00	22.58	0.84

1/ See Table 1 for ingredient levels.

2/ Per metric ton of fortified rice.

3/ One maund = 82 lbs.

Thus, depending on the eventual price of threonine, the expense of fortifying rice with sufficient amounts of vitamins, iron and amino acids to have a major impact on malnutrition on those consuming the fortified rice would be $0.47 to $0.84 per maund of fortified rice. Consideration could of course be given to fortification with vitamins and minerals only. The vitamin and mineral fortification costs are only $0.68 per metric ton of fortified rice or approximately $0.025 per maund.

These costs need to be weighed in the context of benefits, as well as cost-benefit relationships for other development activities. That is one of the reasons we suggest that serious consideration be given to pilot projects designed to evaluate benefits derived from fortification under East Pakistan conditions.

Wheat - atta

Since large quantities of imported wheat are distributed by the food ration system of East Pakistan and in turn substantial numbers of people consume a relatively large proportion of wheat, we have also calculated the cost of fortifying atta.

Since wheat is not deficient in threonine, atta fortification is much cheaper than rice fortification. We estimate the cost to be approximately 20 cents per maund. The levels of recommended fortification and related costs are shown in Table 3.

TABLE 3

WHEAT FORTIFICATION: RECOMMENDED LEVELS OF NUTRIENTS AND COSTS

Nutrient	Amount per kg. wheat	Cost per metric ton of wheat
		-U.S. dollars-
Thiamine	4.19 mg.	.062
Riboflavin	2.52 "	.081
Niacin	30.14 "	.068
Iron	26.40 "	.029
Vitamin A	10,000 I.U.	.50
Lysine	2 gms.	4.40
		5.14 1/

1/ Cost of premix preparation would add approximately 25 cents to fortification cost per metric ton.

The Marketing System

Fortification programs can be organized in a number of ways. In most cases, however, primary consideration is given to foods consumed widely but with a marketing system having a small number of large entities at one or more levels of the marketing chain. Thus, the characteristics of the marketing system for rice, the predominant cereal produced and consumed in East Pakistan, and the food distribution system for handling imported cereals are of primary importance in appraising the long run possibilities for fortification and in considering alternative approaches to initiate fortification efforts.

With one major exception, the cereal marketing system of East Pakistan is dispersed and composed of many small entities. Generally, it does not have a small number of large entities at one or more levels of the marketing chain. The situation has significant implications for cereal fortification in East Pakistan. For example, domestic rice, which provides approximately 11 of the 12 million tons of cereals consumed annually by East Pakistan, is grown and milled throughout the province. An extremely large proportion of this rice never enters commercial channels. A large number of mills and dealers handle the small proportion of rice that is marketed often in small parcels.

In terms of total food grain, domestically produced wheat, pulses and "other cereals" 7/ provide only 3 to 4 percent of consumption. The extent of marketing of these food grains is also small and dispersed.

Imports provide 1 million tons or approximately 8 percent of annual cereal consumption. And in sharp contrast to the uncontrolled marketing of domestically produced cereals, imports are closely-controlled by the Government of East Pakistan Food Department. 8/ This arrangement is the one major exception to the generally dispersed cereal marketing system of East Pakistan. Cereal imports are channeled by the Food Department through port facilities to government-owned godowns and then to licensed ration shops and selected industrial plants located throughout the Province.

In recent years, wheat distributed by the Food Department has been two to three times the quantity of rice distributed. There are three major types of cereal distribution by the Food Department: (1) statutory rationing, (2) industrial rationing, and (3) modified rationing.

Statutory rationing is in effect in the three major metropolitan areas of Chittagong town, Dacca town and Narayanganj town. In these areas, each

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7/ "other cereals" include jowar, bajra, barley, maize and others.

8/ There is a compulsory procurement by the Food Department of cereals in border areas which are in turn distributed through ration shops. However, the amounts are extremely small averaging only 13,000 tons in the most recent three years.

individual, regardless of income, is eligible to obtain food including rice and wheat from the ration shops.

Prices in these shops are seldom changed and are usually below the open market prices. However, the price differential varies during the year and of course is influenced by factors such as weather, harvest movements and quality.

The Food Department provides cereals and other selected foods to industrial concerns. This food is, in turn, distributed to workers in their plants on the basis of family size and type of work performed. Often the cereals are priced to the worker below the price the industrial concerns pays the Food Department. At the present time workers are required to take both rice and wheat. The specific amounts vary from plant to plant and by types of family members. The ratio of rice to wheat is usually 1 part rice to 1 or 2 parts wheat. Some industrial concerns grind the wheat into atta before distributing it to their workers. Others handle it as the licensed ration shops by distributing it as grain. The consumer then has the wheat milled into atta in nearby small mills.

The types of industrial concerns participating in this program vary. We noted jute mills, textile mills, cotton mills, paper mills and tea gardens were participating. Often these same companies operate medical facilities for laborers and their families.

Modified rationing is in effect in all areas in which statutory rationing is not in effect.

In these areas persons are categorized by level of income or by amount of taxes assessed (which corresponds to wealth and/or income). For example in the Dinajpur area all individuals having incomes less than 50 rupees per month are placed in category A, those with somewhat higher incomes in category B and so forth. Food is then provided through the licensed ration shops on the basis of available supplies and according to priority with the lowest income people having highest priority.

There are a number of features of the East Pakistan cereal marketing system which are relevant to consideration of cereal fortification: 9/

1. A very large number of farmers produce paddy with production occurring in practically every locale of the Province.

2. A large portion, 80 to 90 percent, of East Pakistan rice does not enter commercial channels in sizable transactions.

3. A very large number of entities deal in paddy and rice. For example, in the Chittagong District it is estimated that there are some 10,000 dealers with about 2,500 licensed to handle transactions of more than 20 md.

9/ The information relative to E. Pakistan marketing contained in this report is based on the personal investigations of the team as well as Muhammad Osman Farruk, "The Structure and Performance of the Rice Marketing System in East Pakistan," Ph.D. thesis, Cornell University, 1970. Farruk's thesis was carried out under the auspices of the Cornell University/USAID Prices Research Contract.

4. Government intervention in the marketing of paddy and rice produced in East Pakistan is limited to small amounts obtained by the Government through the compulsory procurement program in border areas. Annual procurement averaged only 13 thousand long tons in the three years 1967-69.

5. There are over 100 rice mills of varying size. These mills handle only 2 percent of the rice produced in East Pakistan. Also there are over 3,000 small mills in the Province which individually mill small quantities of rice.

6. There are a very few regulations governing the private trade in rice.

7. There is relative ease of entry by new firms who desire to deal in paddy or rice.

8. The relationships among firms marketing paddy and rice appear to be competitive.

9. Total consumption of cereals amounts to approximately 12 million tons. Approximately 11 million tons are accounted for by East Pakistan rice production. Other cereal production is extremely small. Imports approximate 1 million tons a year. About one fourth to one third of this amount is rice. The remainder is wheat.

10. Cereal imports are channeled by the Food Department through port facilities, to government-owned godowns and then to licensed ration shops and selected industrial plants located throughout the Province.

11. Most groups of consumers obtain the rice they consume from various sources. However, the people in some areas such as the D_1 ration zone of Dacca town and workers of some companies obtain from ration shops relatively large proportions (as high as 80 to 90 percent) of the cereals they consume.

12. Distribution of food through ration shops makes rice and wheat, as well as selected other foods, available to lower income people in "modified ration areas" and to all people in the three "statutory ration areas" of Chittagong town, Dacca town, and Narayanganj town. Laborers of large industrial concerns obtain through company facilities cereals which are made available to these industries by the Food Department.

13. In most cases ration card holder patrons of ration shops are entitled to three seers (1 seer = 2 lbs.) of cereal per week,

one of rice and two of wheat. However, this is not always the case. For example, in some companies heavy manual workers are entitled to one seer of rice and two and half seers of wheat.

14. The total amount of cereals distributed through the food distribution system is approximately 8 to 10 percent of cereal consumption in the Province. For the three years ending July 1, 1969, it was 9.4 per cent for all cereals, 3.5 percent for rice and 90 per cent for wheat.

This marketing system naturally places extraordinary restraints on the type and scope of fortification programs which might eventually prove feasible for East Pakistan. Obviously a mandatory fortification program could not be enforced because of the large proportion of cereals which do not enter commercial channels.

We conclude that the food rationing system should be given close attention in planning any cereal fortification scheme. Further, because of the dominant role of wheat in East Pakistan cereal imports, consideration should be given to wheat as well as rice fortification.

Potentially the entire amount of cereal distributed under the auspices of the Food Department through ration shops and industrial concerns could be fortified under a mandatory program. And if fortified premix could be successfully marketed, it would be possible to have a nutritional impact on the consumers of the very large amounts of rice that do not enter commercial channels. Also, it would seem administratively possible to arrange for the fortification of cereal milled by the larger rice mills and perhaps by large dealers. However, the consumption of this rice is probably widely scattered, thus dissipating the potential impact of it being fortified.

Suggested Projects

We think the Government of East Pakistan should postpone a decision at this time with respect to the feasibility of these approaches. There is not sufficient information about these major alternatives. More needs to be known with respect to medical benefits, administrative programs and mechanical techniques of fortification under East Pakistan conditions. Also, there are alternative approaches to nutrition which logically should also be considered.

Therefore, we propose that the Government consider the implementation of three pilot fortification projects:

1. Fortification of cereal distributed through company ration shops (Industrial study).

2. Fortification of cereal distributed through the D1 ration zone of Dacca town (Urban study).

3. Marketing and promotion of fortified premix for rice.

The information gained from these projects would be helpful to the Government in the future in selecting among alternative programs designed to improve the health of the Pakistani people. If the Government approves the recommendations of this report and undertakes to initiate pilot projects, Pakistani personnel should be assigned responsibility to develop and define methodology, costs and timing of the projects. Likewise, AID should appoint a full time nutrition advisor who would have primary responsibility to assist in the implementation of these projects. Also, AID should provide needed consultants for the projects.

The three projects could be carried out simultaneously. However, the Government of East Pakistan may find it preferrable to initiate the second study a year or so after the first study, and perhaps start the third study another year later. In this way administrative and evaluation requirements would be spread over a larger time period. Also, experience gained in the earlier projects would be valuable in formulating the later projects. A description of the three pilot projects follows:

Industrial Study

a. Primary objectives of project:

1. Define technological procedures necessary to fortify cereals under East Pakistan's processing and marketing conditions.

2. Measure effect of cereal fortification on health of recipients.

b. Secondary objectives of project:

1. Evaluate to extent possible the effect of fortification on economic activity of recipients. For example, work absenteeism might be measured.

2. Ascertain consumer acceptance.

c. Scope of project:

The size of the project would depend on the companies selected and decisions with respect to the number of fortification mixes that are to be evaluated. We suggest that no more than two fortification mixes be studied. In turn there would be three groups of at least 2,000 people each. One would be the control group. Another would receive cereal fortified with vitamins, minerals and amino acids. The third group would receive cereal fortified with vitamins and minerals.

Approximately 8,000 md. (328 long tons) of cereal would be involved annually for each group of 2,000 people. If this were half rice and half wheat, the estimated cost of fortified premix for the vitamin and mineral fortified group would be $212 per year. For the vitamin, mineral and amino

acid group it would be $2,740 to $4,150 per year depending on the price of the threonine. For the control group the cost would be less than $100 per year.

d. Suggested criteria for selection of specific project location:

1. Interest of company in health and nutrition of workers and their families.

2. Facilities and attitudes of company medical officers toward medical evaluations.

3. Stability of population which would participate in project.

4. Proportion of cereals consumed by project group which are obtained from the company-operated ration shops.

5. Administrative and management capability and interest of company to devise, innovate and adjust mechanics of fortifying cereals.

6. Economic level of project group and their representativeness of the undernourished groups in East Pakistan.

A number of possibilities for this project's location should be considered. The team visited jute mills, one paper mill and a tea garden. Of these companies visited, the James Finlay and Company, Ltd. tea gardens most closely meet the criteria number 1 through 5. However, the income level and health of these families may be higher than many families of men working in jute, paper or cotton mills. Further, they have a religious background different from most East Pakistanis. On the other hand, the availability of baseline medical data and possible interest of management appears to be superior to that of the other companies visited. Perhaps other companies which did not come to the attention of the team would meet all seven criteria.

e. Duration of project:

A total of 36 months divided as follows:

First year:

--Gathering of baseline medical and economic data.
--Pre-testing of rice fortification techniques.
--Analysis of baseline medical and economic data.
--Development of system for recording and analyzing data generated during pilot project.

--Pre-testing of measurement techniques.
--Pre-testing of wheat fortification techniques. (Obviously one year is only an approximation of the time required for pretesting. If completed in less than 12 months, the timing of the pilot project could be moved forward. Also consideration should be given to pretesting with students.)

Second and third year:

Implementation of pilot project.

f. Techniques of fortification:

Mixing of rice fortification grains with regular rice at company godown.

Mixing of wheat fortification grains with regular wheat at company godown or addition of wheat fortification material to atta stream if atta grinding is done by a limited number of mills.

Urban Study: Dacca town

a. Primary objectives of project:

1. Development of administrative and management techniques required to effectively implement a program fortifying cereals handled by ration shops.

2. Define the technological procedures necessary to fortify rice under East Pakistan processing and marketing conditions.

3. Measure effect of cereal fortification on health of recipients.

b. Secondary objective of project:

1. Development of techniques for promoting the use of fortification premixes and the marketing of packages of premix.

c. Scope of project:

The size of this project would depend on judgments as to how many ration shops need to be involved in order to adequately test administrative and management techniques, as well as mechanical procedures for fortifying cereals. Ten ration shops might be selected. Our guess is that there would

be approximately 20,000 card holders utilizing these ten shops. We would suggest fortifying with vitamins, minerals and amino acids. Approximately 80,000 md.of cereal would likely be involved each year. If this were half rice and half wheat the cost of fortification material would be as follows:

rice - $19,000 to $33,300 per year depending upon the price of threonine

wheat - $8,130 per year

d. Criteria for selection of D_1 ration zone area of Dacca town:

1. Limited number of ration shops supplied by a small godown.

2. Low income status of a large portion of ration card holders in the area.

3. Small proportion of cereal consumed in area supplied by private trade.

4. Good communication facilities.

There are probably more than one area which comes close to meeting the above criteria. However, the D_1 ration zone of Dacca town is the only one which came to the attention of the team. This area probably has a population of 2 lakhs (200,000) who obtain 80 to 90 percent of their cereal consumption from about 70 ration shops. This possibly amounts to 30,000 metric tons of cereal per year.

Income levels are evidently low. Availability of radio and newspaper communication media is probably among the best in East Pakistan.

We are uncertain about the acceptance of innovative change or the trust of the populace in government programs which should be considered in making a final selection of a site for this pilot project.

e. Duration of project:

A total of 36 months with tasks and time for pretesting similar to that suggested for project focusing on selected companies.

f. Techniques of fortification:

In addition to techniques utilized in the project located at a company, the techniques of packaging fortified premix in

an amount needed to fortify one seer of cereal might be made available. These could be mixed with the cereal at the ration shops.

Promotion and Marketing of Premix Study

a. Primary objective of project:

Design and evaluate alternative techniques of marketing packages of fortified premixes for rice and wheat and promoting their use.

b. Secondary objective of project:

None

c. Scope of project:

The size of the project would depend on judgment as to how large an area and group of people would be required in order to adequately evaluate marketing techniques. It could be an urban area or a rural area. Our guess is that at least 400,000 people should be in the target area. Widely varied techniques would be tested. Some that might be considered include:

1. Coloring the premix.

2. Packaging the mix in amounts needed to fortify one seer of cereal.

3. Offering premix without cost during introductory period.

4. Developing mass media advertising techniques.

5. Numbering packages and making prizes available for numbers drawn by lottery once a week.

d. Suggested criteria for selection of specific project location:

1. Good communication facilities.

2. Acceptance by the people in the area of innovative changes in the past.

3. Interest of community leaders in improved nutrition and innovations.

4. Trust and confidence in community leaders by the people.

e. Duration of project:

A total of 24 months starting one year after the last of the projects and divided as follows:

First year:	Pretesting of marketing and packaging techniques
Second year:	Conduct of pilot project

f. Techniques of fortification:

The consumers could choose whether or not to fortify their rice. Therefore, the mixing would occur at the ration shop, in the retail store or in the consumer's home.

Methods of Evaluation

The scientific evaluation of the effectiveness of any fortification program requires two types of surveillance:one technological in which the ability of the program to introduce the fortification premix into food in the amounts desired is measured; the other medical in which the health benefits derived from the fortification are determined.

Technological evaluation can be accomplished in a number of ways. The most simple but least reliable is to compare the amount of fortification premix used and the amounts of the food being fortified which pass through facilities where fortification is carried out. If too little of the fortification premix is used, this may be considered good evidence that fortification is not being adequately carried out. If the desired amount of fortification premix is used, it may mean that fortification is proceeding as desired. But this would not guarantee that the fortification premix is not being diverted into improper channels. Consequently unscheduled random sampling of the fortified food in the fortification centers, distribution centers and in the homes followed by chemical testing should be conducted regularly to make sure that the added nutrients are present in the food in the amounts desired.

The measurement of the amount of fortification premix present in food presents a variety of problems depending on the food being fortified and the nutrients being used. For wheat flour, an analysis for one of the fortification ingredients can be made. If one of the premix nutrients is present, then this is presumptive evidence that all premix nutrients are present. If the nutrients are not premixed, analyses for all of the nutrients would have to be done on some of the samples.

In the case of rice fortification, it may only be necessary to count the number of RFG's present in a standard amount of rice. This is particularly easy if the RFG's are identifiable by color or shape. If they are not, it may be possible to spray the fortified food with chemicals which react with one or more of the components of the RFG and produce color reactions. This would make it possible to determine the quantity of RFG's (i.e. level of fortification) in the fortified rice. Chemical analysis for one or more of the nutrients may be carried out on a small number of samples to confirm the color test results.

To do the technological monitoring properly, a small laboratory with approximately $3,000 worth of equipment and three educated people will be needed. At least one person with training in food technology and chemistry will have to be hired full time. If fortification projects are carried out in more than one location, the facilities and personnel will not have to be duplicated but additional personnel may be necessary for collecting samples.

For a fortification program to be successful, it is essential that evidence be obtained that the program provides measurable and important health benefits. Medical evaluation can be very complicated, sophisticated and costly, but meaningful data can also be collected in simple inexpensive ways.

Medical evaluation of fortification programs in East Pakistan will be handicapped by the almost complete lack of vital statistics, such as height, weight and even birth dates. Nevertheless, an experimental design for the medical evaluation of a fortification program can be prepared.

Fortification studies may be carried out in populations where caloric deficiency is not a major problem. It will be necessary before a fortification program is initiated to determine by general dietary survey techniques the nutrient intakes of the population to be studied. This does not have to be a very sophisticated study, but it should establish the general food consumption habits of the people to be studied and approximately what percent of their caloric needs the people most likely to suffer from malnutrition are receiving. In any society the people at greatest risk of nutritional deficiency are the preschool children and pregnant and lactating mothers. Medical evaluation of a fortification program should concentrate on the former.

Pilot studies in East Pakistan may involve the fortification of the food supply of many thousands of people. It is not necessary to examine all of them. Instead a representative sample of subjects may be selected randomly for study. It is likely that about 150 preschool children and their mothers in each test group will be sufficient initially.

Prior to the institution of the fortification program, baseline data should be collected from the selected individuals. For the children, the data should include estimates of ages, weights and reclining lengths, triceps and subscapular skin folds thicknesses, and head, arm and chest circumferences. All children selected should be examined by a clinician for visible signs of malnutrition and other diseases. If iron is included in the fortification mixture, as it should be, hemoglobin and hematocrit determinations should be done on the children and their mothers.

At yearly intervals after the fortification program begins, these examinations should be repeated. In addition, birth weights of infants born in the rest of the population of the experimental and control groups should be recorded and they and their mothers should be added to the experimental groups. If possible, records of deaths, miscarriages and stillbirths should be obtained. If the studies are done in industrial populations attached to large industries, records of days lost due to illness may be of value. In the jute mills all workers are allowed 14 days sick yearly with pay. All workers take at least 14 days whether ill or not. However, the data on numbers of workers ill for more than 14 days each year may be useful.

It is likely that a study of this sort will last at least two years from the time the fortification begins. A great amount of data will be collected on many people in the experimental and control groups. In order to ensure that the data collected will be usable, a careful system of keeping records will have to be devised. Each individual in the study will have to be given an identification number and data obtained on each will have to be recorded systematically on computer cards in such a way that the data can be easily retrieved and subjected to statistical analysis. The methodology for doing this has been worked out. Dr. A. H. Morsley, Chief of the Epidemiology Section of the Pakistan-Seato Cholera Research Laboratory, has said that he and his

associates would probably be willing to supply consultative services.

In order to do these studies at least one physician trained to recognize signs of nutritional disease and interested in doing this study will be necessary. He will require three or four assistants to do the anthropometric measurements and to record data. Nutritionists will be needed to do the initial dietary survey. It appears that the one group of people who have had experience in doing this type of work in Pakistan are the nutritionists who participated in the East Pakistan Survey of 1964-66 and it might be advisable to select the nutritionists from this group.

There will not be many pieces of expensive equipment needed for the medical evaluations. Some inexpensive equipment which will be needed are as follows: small scales for weighing food, a couple of clinical scales for weighing new babies and preschool children, a devise for obtaining reclining lengths, skinfold calipers and steel tapes for making the anthropometric measurements and equipment for doing the hemaglobin and hematocrit determinations. The equipment will cost approximately $2,000 and another $2,000 will be necessary for the handling of the data.

The success of the fortification program and its evaluations are dependent on the personnel who work in the program. It will be necessary to have one person act as director of the entire project. He must be capable, conscientious and thoroughly briefed on the problems of doing fortification studies and evaluating them. All members of the fortification team must be thoroughly trained. All techniques used must be rigidly standardized and standards of acceptable variance in the measurements used must be developed. Throughout the studies these standards must be maintained or the value of the studies may be compromised. For instance, the inaccuracies in measuring height and weight as these are commonly done by medical and non-medical people are of such a magnitude that unless members of the evaluation group could make them accurately with minimal variation between examiners, their imprecision could seriously threaten the entire medical evaluation effort. To initiate a fortification program poorly would be a great disservice because such an effort might preclude for all time the use of this potentially very useful technique in the effort to eliminate malnutrition in East Pakistan.

In addition to scientific evaluation, economic and administrative evaluations should be carried out. These include the following:

1. Measurement of costs and extrapolation of these costs for possible future programs.

2. Estimation of cost-sales relationships for advertising and other promotion techniques.

3. Estimation of economic demand for fortified premix.

4. Estimation of economic and social costs of taking no action with respect to malnutrition.

5. Testing alternative administrative procedures that might be utilized for large scale fortification programs.

Successful economic evaluation will depend on the capability of an economist engaged to cooperate in the project. He should be well trained and have a knowledge of East Pakistan rice marketing. Hopefully he would also have an interest in economics of promotion and advertising. We guess that during the three years duration of the project, approximately 24 man months of work will be needed. But the exact amount would be dependent on the structure of the projects and also on decisions with respect to related work such as estimating the "costs" of taking no action with respect to malnutrition.

Expertise on communications, promotion and advertising will also be needed. However, we are uncertain as to the amount of work in this area that will be involved.

Appendix

TABLE A-1

E. PAKISTAN, PER CAPITA PRODUCTION OF CEREALS AVAILABLE FOR FOOD CONSUMPTION 1/

Year	Cereals	Pulses
	----- pounds per year -----	
1958-59	274.5	9.6
1959-60	322.7	7.3
1960-61	350.4	8.1
1961-62	337.2	8.1
1962-63	301.1	5.6
1963-64	347.4	5.0
1964-65	332.0	7.1
1965-66	322.8	7.4
1966-67	283.3	7.3
1967-68	319.8	6.9
1968-69	315.6	6.5

1/ Production less 10 percent allowance for seed waste and feed.

TABLE A-2

EAST PAKISTAN, PRODUCTION OF CEREALS AND PULSES

Year	Rice	Other Cereals	Pulses
	1,000 long tons		
1958-59	6,921	117	247
1959-60	8,482	75	193
1960-61	9,519	92	223
1961-62	9,465	104	230
1962-63	8,730	110	166
1963-64	10,456	88	153
1964-65	10,337	85	223
1965-66	10,380	101	240
1966-67	9,397	118	244
1967-68	10,986	124	240
1968-69	11,165	179	234

Source: Statistical Digest of East Pakistan, No. 5, 1968, East Pakistan Bureau of Statistics.

TABLE A-3

EAST PAKISTAN, POPULATION AND PER CAPITA AVAILABILITIES OF CEREALS AND PULSES

Year	Population 1/	Availabilities Cereals and Pulses 2/
	-- millions --	-- pounds --
1958-59	51.68 3/	310.4
1959-60	53.46 3/	355.3
1960-61	55.30	376.3
1961-62	57.21	365.0
1962-63	59.18	352.0
1963-64	61.20	375.3
1964-65	63.29	363.8
1965-66	65.46	361.8
1966-67	67.70	325.8
1967-68	70.04	347.6
1968-69	72.46	353.7
1969-70	74.98	

1/ Sources: Statistical Digest of East Pakistan, No. 5, 1968, East Pakistan No. 5, 1968; East Pakistan Bureau of Statistics, Table 2.5 (according to Table 2.2 A, No. 3, 1965 population estimates given assume constant fertility and mortality).

2/ Per capital production plus per capita distribution of cereals. See tables A-1 and A-5.

3/ Computed on basis of growth rate from 1960-61 to 1961-62.

TABLE A-4

EAST PAKISTAN: FOOD GRAIN IMPORTS 1/

Year	Rice	Wheat	Total
	---------- 1,000 long tons ----------		
1960-61	491	235 2/	726
1961-62	206	202 2/	408
1962-63	542	898 2/	1440
1963-64	347	656	1003
1964-65	92	250	342
1965-66	358	529	887
1966-67	432	647	1164 3/
1967-68	308	712	1020
1968-69	236	884	1120

Source: Food Department, Government of East Pakistan.

1/ Includes imports from West Pakistan.

2/ Includes 15 to 20 thousand tons of wheat products for each of the three years.

3/ Includes 85 thousand tons of maize.

TABLE A-5

EAST PAKISTAN: SELECTED CEREAL STATISTICS

Year	International Procurement	Distributed 1/	
	Rice	Rice	Wheat
	1,000 long tons		
1958-59	-	532 2/	74 2/
1959-60	41	485 3/	118 3/
1960-61	27	308	139
1961-62	10	349	162
1962-63	4	597	612
1963-64	124	240	395
1964-65	13	234	475
1965-66	93	425	513
1966-67	8	499	581
1967-68	22	231	434
1968-69	10	256	782

Source: 1958 and 1959 and 1960: Statistical Digest of East Pakistan, No. 5, 1968, East Pakistan Bureau of Statistics. 1960-61 forward: US/AID Dacca.

1/ By GOEP Food Department.

2/ Average of data for calendar 1958 and 1959.

3/ Average of data for calendar 1959 and 1960.